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WHITINGS ON THE COASTS OF THE AMERICAN CONTINENTS

By ISAAC GINSBURG

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WHITINGS ON THE COASTS OF THE AMERICAN CONTINENTS

By Isaac Ginsburg, *Fishery Research Biologist*

Fishes belonging to the genus *Merluccius* are commercial species of much economic importance in the aggregate, in the coastal waters of the United States, in other American countries, and in other parts of the world. Notwithstanding the relative abundance of these fishes a remarkable misapprehension exists regarding the species that make up the considerable catch in the northwestern Atlantic. It is now generally assumed that only one species of *Merluccius* occurs on the east coast of the United States, and conclusions in earlier studies of these fishes have been based on this assumption. However, two distinct species occur in this region. The two species are well-divergent, and single specimens are easily separable, and identifiable with the species to which they belong.

In view of the existence of two very different species in this region, it is to be expected that many of the conclusions regarding the bionomics and economics that were made as a result of studies of the supposedly single species, will now become obsolete. A reappraisal of existing data is needed to accord with this newly discovered fact. Bibliographies of the whitings need to be segregated by species. Some of the published observations and data, based on a composite of two distinct species, may now have to be reconsidered. It may be impossible to segregate some published records by species, and such references will have to be considered as applying to a mixture of two species.

The primary objective of this study is the determination of the species of *Merluccius* in the northwestern Atlantic, including the Gulf of Mexico; specimens of other species available in the National Museum have been studied also, for comparative purposes. The northwestern Atlantic species are best considered in relation to the other American species; the eight American species, including two new species, are therefore treated here. Since a comparative world-wide study of the species of *Merluccius* is one of the desiderata of fish taxonomy, a secondary purpose of this report is to present data toward such a revision.

Merluccius Rafinesque

Merluccius Rafinesque, Caratteri di alcuni nuovi generi e nuove specie di animali e pianti della Sicilia, p. 25, 1810 (genotype *Gadus merlucius* Linnaeus by later designation).

Jordan and Gilbert, Bull. U. S. Nat. Mus. 16: 808 (1882), 1883 (*Gadus merlucius* Linnaeus designated as genotype).

Characters common to the American species.—Elongate; well-compressed; rather spindle-shaped, but posterior taper more pronounced than anterior one. Top of head flat; interorbital broad, wider than eye or subequal to it, and only a little less than length of snout. Eyes large to notably large. Snout depressed, broad, rounded, moderately longer than eye to twice as long as its diameter. Mouth moderately large, angle of gape under anterior margin of eye or a little behind, articulation of mandible under posterior margin of eye or a little behind; moderately inclined, a horizontal through anterior part of gape passing nearly through middle of eye, varying moderately both ways; terminal or subterminal, lower jaw subequal to or usually a little longer than upper jaw. Maxillary reaching to under posterior margin of pupil, varying a little both ways, its distal outline characteristically concave asymmetrically, the lower distal angle somewhat projecting. Teeth well-developed, sharp, in two irregular rows in jaws and on vomer; outer teeth fixed, widely or moderately spaced, inner teeth larger and depressible, moderately spaced; teeth in jaws larger at anterior part, considerably smaller at their articulated end; in upper jaw a small area at symphysis without teeth; no palatine teeth. Opercle subtriangular in outline its posterior part flexible, merging almost imperceptibly with soft membranous border, without spines. Gill opening rather wide, gill membranes united at a point variably under eye.

Pseudobranchiae absent. Gill rakers well-developed, rather few or in moderate numbers, usually abruptly separable from the low tubercle-like outgrowths at both ends of arch. Barbels absent.

Scales cycloid, small, in about 112–186 oblique rows over lateral line, from a point over upper anterior corner of gill opening to end of hypural; body all scaled, including chest and fleshy pectoral base; dorsal aspect of head and antedorsal area scaled, except an irregular small or moderate area at anterior end of snout; opercle scaled; lateral aspect of snout continuously to a variable point under eye, and maxillary scaleless, except side of snout with a lengthwise strip of scales in individual variants of *albidus;* cheek, preopercle and interopercle only partly scaled, scaleless in moderate or greater part, except in *albidus* (p. 192) and *magnoculus* (p. 194); ventral aspect of head scaleless; scales on head smaller than those on body, those on anterior part of head minute; caudal scaled for a variable area at its base, scaleless distally; pelvic and pectoral almost scaleless, with only a small scaled area at base; dorsal and anal fins scaleless, except a small anterior portion of posterior part of second dorsal and anal partly scaled or scaleless. (The scalation is incompletely preserved in most specimens examined and the foregoing statements might need some modification. See also following discussion).

Lateral line begins over gill opening and continues nearly straight all the way, or slightly and broadly curved anteriorly, to base of caudal. Two well-separated dorsal fins; first dorsal roughly triangular with 10–14 rays, anterior three rays unevenly graduated, the third longest, the first subequal to sixth or fifth, the second moderately shorter than third or subequal to it, the fourth a little shorter than third or subequal to it, thence decreasing in length backward, the decrease being slow to fifth or sixth ray, thence becoming rapid, last ray short; second dorsal with 36–45 rays, incompletely divided by an emargination into two parts, the number of rays in the two parts equal, varying to posterior part having a few more rays (the relative numbers not accurately determinable, the two parts of the fin not delimitable definitely, with the great majority of available specimens having the fins damaged), the rays in anterior part rather widely spaced, those in posterior part somewhat crowded in comparison, especially in its anterior portion; anal also with 36–45 rays, but its counts for a given species, anyway for most species examined, averaging slightly higher than those of dorsal, its structure similar to that of second dorsal; rays in the three fins segmented and branched, except first ray of first dorsal unsegmented and unbranched and first one or two anal rays and last one to four rays in all three fins segmented but not branched. Pectoral with 12–18 rays, notably narrow. Pelvic inserted at a moderate distance in advance of pectoral, normally with 7 rays. (Of 167 specimens of all species counted, on right side, all but 3 have 7 rays, the 3 variants having 6 rays on right side and 7 on left.) Caudal short, rounded in the smaller specimens becoming emarginate with growth; tail moderately isocercal, posterior part of vertebral column moderately tapering, its end well-rounded; outer caudal rays growing progressively shorter anteriorly, extending symmetrically for some distance above and below end of caudal peduncle.

The palate and the inner walls of the gill chamber are very dark to black. The peritoneum is solid black, or dark or silvery stippled and spotted with black, depending on the species and growth changes within the species. Externally it is difficult to determine specific color differences, if any, in preserved specimens of *Merluccius.* In general, preserved specimens have silvery, golden, brownish, dusky or dark shades. The fins are dusky or dark in part. There are no definite distinctive specific color marks.

Characters useful in distinguishing the species.—The preceding description outlines some external taxonomic characters that are more or less common to the eight American species here considered. The characters that are of greater or lesser utility in distinguishing the species are hereafter discussed in some detail. The species of *Merluccius* by and large are very closely related; but they are not too difficult to distinguish when the species-characters are accurately determined, and tabulated for ease of comparison.

Gill rakers.—The number of gill rakers constitutes an important character in distinguishing the species of *Merluccius.* It is the chief character that may be used in separating the two common, sympatric species on the Atlantic coast of the United States, and is useful in other species as well. It is therefore important to consider in

some detail the structure of the gill rakers and the method of counting them used during this investigation.

As in many other fishes the outer gill arch in *Merluccius*, in addition to the well-developed gill rakers, has outgrowths at both ends that may be described as low spinulose tubercles, sometimes designated "rudiments" by authors. In the species of *Merluccius* examined, the tubercles number 0–3 on the upper limb and 2–12 on the lower limb. The tubercles are usually fairly separated in the small specimens, but they differ considerably in size or, rather, extent. In the larger specimens some of the tubercles on the lower limb tend to coalesce, and their number cannot be determined with precision. To a lesser extent coalescense also occurs sometimes in small specimens. Because of the latter difficulty combined with the considerable individual variability in their number, the tubercle count is not well-adapted to be used as a character in separating the species. On the other hand, in the great majority of specimens of these species, the change from the gill rakers to the tubercles is abrupt and usually the former are readily countable with precision, although the gill rakers decrease in size from the angle outward both ways. Therefore, the numbers of gill rakers here given do not include the tubercles.

In some individual variants, the change from the gill rakers to the tubercles is not so abrupt. The outgrowth standing next to the tubercles on one or both limbs of the arch is very short approaching the size of a tubercle. In many such variants the outgrowth though very short is rather tapering and somewhat conical and was included in the count. Very few of the many specimens examined presented doubt in my mind whether to include such an outgrowth near the border line in the gill raker count. Because of the latter variants the count is apt to differ slightly with the individual observer, or seldom in successive counts of the same specimen made by the same observer. Nevertheless, while this method of counting is not precise, it approaches precision more nearly than that of other methods of counting. When the gill raker count is based on numbers of specimens, such possible differences are negligible, especially where the difference in the gill raker count of the species is pronounced.

There might be a slight growth change in the gill raker count. That is, in variants in which the end gill raker is very short, it might change to a tubercle with growth. However, I was unable to determine this point definitely. While the counts on which the tables are based have been determined with large and small specimens, I did not have a sufficient number of specimens in a graded size-range from any one locality to determine growth changes. As far as my observations go, possible growth changes in the gill raker count, if any, are negligible.

The frequency distributions in the number of gill rakers are given in tables 1–3. As the number of available specimens of *polylepis*, *productus*, *angustimanus*, *peruanus*, and *gayi* are relatively few, the gill raker count was made on both sides of each specimen and entered in the tables independently. The count often differs on both sides. In the other species the count was made on one side only, generally on the right side unless, rarely, for some reason an accurate count on that side was not possible when the gill rakers on the other side were counted.

Scalation.—The scales are arranged with fair regularity and the number of rows above the lateral line, is fairly determinable in any one specimen that has the scalation complete, or nearly so. When so determined, the number of scales seems to constitute a species character in some instances. However, the application of this character is difficult, and except for *polylepis*, it is only of minor practical value, because the scalation is more or less incompletely retained in the great majority of preserved specimens, and the number of rows is not accurately determinable in such specimens.

The number of oblique rows of scales over the lateral line, from a point over the upper anterior angle of the gill opening to the end of the hypural, is stated under the account of every species. The given range of the count for each species has been determined on a few specimens (the number of which is stated in parenthesis) that were best preserved for this purpose. In some species, however, the best specimens examined were none too good for this purpose. Consequently, the given ranges of the scale counts are only roughly approximate, probably by a rather wide margin in some instances.

The extent of scalation is described under the genus (p. 188). The statements made there seem to apply in general to the genus as a whole, but the finer details cannot be elaborated now. Because the scalation is incompletely or very poorly preserved in the great majority of specimens examined, it is not possible to determine intraspecific individual variability or average specific differences, if any, in the extent of scalation, especially on the fins. Also, it is not possible to determine from the available specimens, growth changes in the scalation. Consequently, statements made under the genus and species headings might need some modification on examination of better-preserved specimens.

The extent of scalation of the side of the head might form a basis for the division of the species of *Merluccius* into two major groups, perhaps of subgeneric importance, as it is correlated with another character. In *albidus* and *magnoculus*, the side of the head, excluding the snout and maxillary, is almost completely scaled, and correlated with this the number of gill rakers is relatively few. (The same combination of characters was observed in one large specimen from Norway, 17372, see p. 193.) The other American species, on the other hand, have the cheek, preopercle, and interopercle incompletely scaled in combination with a greater number of gill rakers. However, because the scalation is defective, poorly preserved in the great majority of specimens, this character is not easy to use in practice. Moreover, the taxonomic value of this character may best be judged by a study and comparison of all the species on a world-wide basis.

Fin rays.—The number of rays in the second dorsal and anal is of considerable importance as taxonomic characters in some instances, as in the separation of *angustimanus* from *productus*, the distinction of the two subspecies of *gayi*, and the proper distinction of *polylepis*. In other instances, the numbers of these rays show lesser and variable degrees of divergence. The number of rays in the first dorsal and pectoral generally show divergences of subspecies magnitude or less when related species are compared for these numbers. Species differences in these numbers are shown in tables 4–7 and discussed under the accounts of the species. The rather narrow spread of the distribution for each species in the number of dorsal and anal rays is noteworthy considering the comparatively numerous rays. The anal count averages slightly higher, at least in most species.

Measurements.—Some proportional measurements are of considerable importance in distinguishing the species as follows. Measurements here given in the text and tables are expressed as percentages of the standard length, that is, the distance from the tip of the snout to the end of the hypural as determined externally by flexing the caudal fin, the decimal point being omitted in the tables for brevity. Because measurements of the same species differ with the size of the fish, changing with growth, sometimes considerably so, the data are segregated in the tables by size groups. In general, judged by the specimens examined the greatest diverence in proportional measurements in *Merluccius* seems to be shown by the smaller size groups. With growth the extent of divergence appears to become lessened and perhaps disappears in some instances.

The head length is of value in separating some of the species and is used in the key for this purpose. It is long in *angustimanus* and *gayi*, especially in the subspecies *peruanus*, and short or of medium length in *polylepis*, *hubbsi*, *bilinearis*, and *productus*. It is also rather long in *magnoculus* as compared with its nearest relative, *albidus*. The head length differs moderately with size, becoming shorter, on the average, with growth. Hence it is necessary to compare specimens of approximately like size. The head ends in a soft membranous border. In well-preserved specimens the hard part of the opercle usually thins out gradually to the soft border so that no definite line of demarcation marks off the latter. Consequently, this measurement was made to the margin of the membranous border.

The pelvic fin was measured from the point of articulation of the outer rays as determined on the outside by flexing the rays, to the tip of the ray extending farthest backward. It is relatively long in *albidus*, *hubbsi*, and *bilinearis*, and short in *magnoculus*, *productus*, *angustimanus*, and *gayi*. This measurement also differs with growth, and specimens of approximately like size are best compared. The difference in this measurement between *bilinearis* and *productus* is such that even when those of all sizes are lumped together, as in

table 9 (p. 205), the distributions of the two species are separated by a gap.

The pectoral length was measured from the point of articulation of the upper rays as determined externally by flexing, to the tip of the ray extending farthest backward. It is especially useful in distinguishing *magnoculus* from *albidus* and *hubbsi* from *gayi*. The pectoral appears to increase in length moderately with growth in some species and to scarcely change in proportion with growth in others.

The other measurements tabulated, namely those of the maxillary, eye, snout, depth and caudal, perhaps named in order of importance, are of secondary or of minor importance. In general, species differences in these measurements are overlapping and expressible in terms of averages only; although in some instances the divergence is considerable, such as the difference in the length of the maxillary or the snout between *albidus* and *magnoculus*.

The snout was measured from its tip to the anterior soft border of the eye; the eye between its soft borders; the depth at the origin of the first dorsal.

The fin rays including those of the pelvic, pectoral, and caudal are often more or less damaged, hence these measurements are not altogether satisfactory characters to use; but those of the pectoral and pelvic are of considerable value in distinguishing the species. In making up the tables an attempt was made to exclude specimens with damaged fins, but this is not always evident, and hence the tables might be slightly lacking in precision.

Caudal shape and its measurement.—In the smaller specimens the posterior margin of the caudal is rounded with the middle rays longest. With growth it becomes emarginate, and the rays near the upper and lower margin are then longest. The approximate size at which the change takes place evidently differs with the species; but this could not be definitely determined, because sufficiently graded size ranges are unavailable for the several species, moreover the caudals are damaged in most preserved specimens examined. The approximate size at which the change takes place, as far as determinable by the specimens examined is stated in the accounts of the several species. It appears that in *peruanus* the change takes place at a smaller size and in *hubbsi* at a larger size than in other species for which specimens in graded size ranges are available. In two species at least, *albidus* and *bilinearis*, the size at which the caudal becomes emarginate appears to vary greatly with the individual.

Judged by the poor material examined, that is, poor from the viewpoint of studying this development, it seems that the main successive stages are as follows: First, the middle rays become shortened in relation to the adjacent rays and the posterior margin of the fin becomes approximately truncate. Then, two rays near the upper margin become slightly longer than those below them, and a moderate extent of the upper part of the fin becomes slightly emarginate while the rest is still truncate. Finally, the entire caudal becomes moderately or well-emarginate in the larger specimens of the several species.

Because of its change with growth, it is difficult to state properly the caudal length in *Merluccius* and to determine the species differences in that length, if any. The best way is to compare growth changes between the species of those rays that undergo the greatest growth change, namely, those near the middle and those near the upper or lower margin. However, this ideal way was not possible of attainment because of the incompleteness of the material examined. On account of the difficulties, the caudal measurements here recorded were made from the end of the hypural on the midline to the end of the longest rays, which are generally situated at the middle of the fin in the smaller specimens and near the upper margin in the larger fish. Consequently, these measurements do not express the change with growth of the particular rays. Also, measurements of the several species are not strictly comparable; because at a given standard length the longest ray in one species may be the one at the middle, and in another species of the same length it may be at the upper margin. Although not strictly comparable, the given measurements present the approximate caudal length in the several species.

Measurement of intergradation and divergence.—In the following accounts of the species and subspecies, the sections headed Comparison are devoted to a discussion of the distinguishing characters between the several species or subspe-

cies. The statements made regarding degrees of intergradation or divergence, whether of species, of subspecies, or less than subspecies magnitude are based on criteria previously established by me in another paper (1938). In tables 1–7 presenting counts of gill rakers and fin rays in the form of frequency distributions, one line for each species gives the distribution in the number of specimens, and a second line immediately underneath gives the distribution in percentages. The latter numbers enable the reader to make a quick determination of the indices of intergradation and divergence between any two species compared as proposed in the paper cited.

KEY TO THE AMERICAN SPECIES OF MERLUCCIUS

1a. Total number of gill rakers on outer arch (not counting tubercles, see discussion in text) 9–11. Side of head almost completely scaled.
2a. In 11 specimens 173–293 mm. in standard length, head 27.4–30.1, pelvic 15.5–17.7, pectoral 18.3–20.9 (for measurements of other lengths see tables 8–10). Pectoral rays modally 15, varying 13–16. Atlantic coast of the United States ..... *albidus* (p. 192)
2b. In 20 specimens 189–290 mm. in standard length, head 29.6–31.3, pelvic 13.4–15.9, pectoral 15.8–19.2. Pectoral rays modally 13, varying 12–15. Gulf of Mexico ..... *magnoculus* (p. 194)
1b. Total number of gill rakers on outer arch 13–25. Side of head incompletely scaled.
3a. Total number of gill rakers on outer gill arch 13–15, when 16, in about 12 percent of specimens of *hubbsi*, head 27.6–30.7. Atlantic and Pacific coasts of South America.
4a. Rays in second dorsal 43–45. Anal rays 42–45. Scales in about 182–186 oblique rows over lateral line from upper angle of gill opening to end of hypural. Chile ..... *polylepis* (p. 195)
4b. Rays in second dorsal and anal 37–40. Scales in about 138–144 rows. Argentina ..... *hubbsi* (p. 197)
3b. Total number of gill rakers on outer gill arch 17–25, except 15–16 in about 5 percent of the specimens of *bilinearis* on Atlantic Coast of United States and Canada, or 16 in about half the specimens of *angustimanus* from the Pacific coast of Central and North America, the latter having the head 31.0–33.3.
5a. Head 26.8–29.2 in specimens 113–158 mm. in standard length; 25.4–28.6 in specimens 181–294 mm.; 26.1–28.4 in specimens 318–367 mm.; 25.5–27.6 in specimens 409–459 mm. East and west coasts of United States and Canada.
6a. Pelvic 14.8–20.5 in specimens 66–442 mm. in standard length (for its change with growth see table 9). Atlantic coast of United States and Canada ..... *bilinearis* (p. 198)
6b. Pelvic 10.8–14.1 in specimens 113–459 mm. Pacific coast of United States and Canada ..... *productus* (p. 199)
5b. Head 32.1–33.5 in specimens 138–161 mm. in standard length; 30.6–32.8 in specimens 235–289 mm.; 28.4–31.5 in specimens 308–389 mm.; 28.0–30.1 in specimens 402–478 mm. Pacific coast of Southern California to Chile.
7a. Total number of gill rakers on first arch 16–17, except 18 in about 6 percent of the specimens. Southern California to Panama ..... *angustimanus* (p. 200)
7b. Total number of gill rakers on first arch 18–25, except 17 in about 5 percent of specimens of *peruanus*. Pacific coast of South America ..... *gayi* sensu lato (p. 201)
8a. Anal rays 36–39. Second dorsal rays 36–40. Peru ..... *gayi peruanus* (p. 202)
8b. Anal rays 39–42. Second dorsal rays 37–42. Chile ..... *gayi gayi* (p. 202)

Merluccius albidus (Mitchill)

Gadus albidus Mitchill, Jour. Acad. Nat. Sci. Philadelphia 1 (2): 409, 1818 (New York)

Description.—Gill rakers 1–3+8–9 or 9–11 in combined number. Dorsal 11–13, 37–40. Anal 37–41. Pectoral rays modally 15, varying 13–16. Proportional measurements about medium, on the whole; head 27.4–30.1, pelvic 15.5–17.7, pectoral 18.3–20.9 (measurments here given referring to same 11 specimens 173–293 mm., standard length; for other measurements and growth changes see tables 8–15). Scales about 129–144 (in 6 specimens). Cheek, preopercle, and interopercle almost wholly scaled; lateral aspect of snout naked or with a lengthwise strip of scales, narrow or of moderate width. Peritoneum solid dark brown or black in the larger specimens; in the smaller fish dark brown or almost black stippled with dots of a more intensely dark color.

The normal size at which the caudal shape changes could not be definitely determined because the caudal is more or less damaged in the great majority of the specimens examined. It appears to have been rounded on one specimen 115 mm. in standard length, truncate in 5 specimens 124–210 mm., and emarginate in 17 specimens 237–626 mm.; but in one specimen 293 mm. it is truncate. Tentatively, then it may be stated in round figures, that in *albidus* the caudal usually becomes truncate at about 125 mm. in standard length and emarginate at about 240 mm., but the change with growth appears to vary much with the individual, sometimes it remains truncate up to about 295 mm. in standard length.

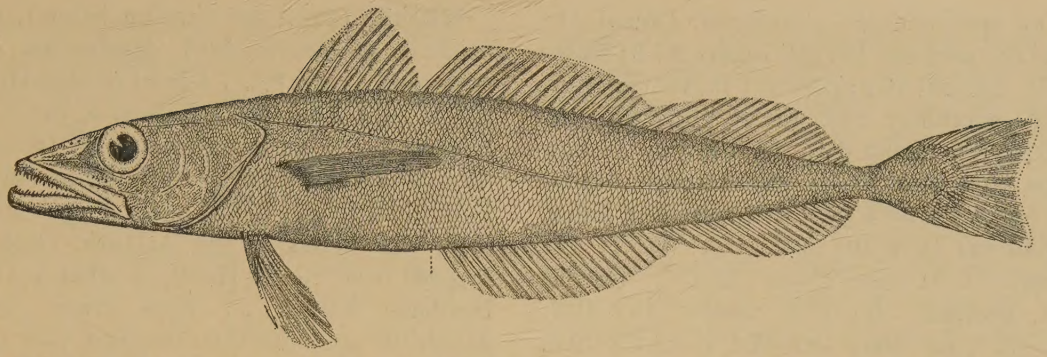

FIGURE 1.—*Merluccius albidus;* U. S. Nat. Mus. 31844; off Long Island, N. Y.; 125 fathoms (39°58′30″ N., 70°37′ W.); 492 mm. Drawn by Mildred H. Carrington.

Neotype.—As two common sympatric species of *Merluccius* are here distinguished where recently only one species was supposed to exist, and Mitchill's early names are applied to both for reasons stated below, while Mitchill's original specimens are presumably not in existence now, it seems desirable to set up neotypes for these two species in order to fix their names definitely. Accordingly, the following specimen is hereby designated as neotype of *albidus*: U. S. Nat. Mus. 31630; Fish Hawk Station 1096; lat. 39°53′ N., long. 69°47′ W.; off Long Island, N. Y.; 317 fathoms; August 11, 1882; 325 mm., 293 mm. in standard length.

Other specimens examined.—Off Long Island, N. Y., 19 constituent samples comprising 29 specimens 33–626 mm. in standard length, taken between latitudes 39°48′30″ and 40°15′30″ and longitudes 71°43′ and 68°54′ (25769, 26049, 26061, 26073, 26190, 28826, 31677, 31686, 31739, 31741, 31822, 31842, 31844, 31863, 44264, 45963–4, 157755–6). Also, one constituent sample each from off the following localities: Cape May, N. J. (39259, 2 specimens 115–124 mm.). Cape Charles (33032, 237 mm.) and Cape Henry (32791, 278 mm.), Va. Savannah (155475, 2 specimens 252–280 mm.), Ga. Cape Canaveral (45920, 445 mm.) and Tortugas (92066, 138 mm.), Fla. Total examined, including the neotype, 38 specimens about 36–691 mm. in 26 constituent samples. Depth records, available for all except 2 constituent samples, range 58–640 fathoms.

The 3 specimens 252–445 mm. in standard length from off Savannah and Cape Canaveral fit in readily in their measurements and counts with the other northern specimens of *albidus* rather than with the Gulf of Mexico *magnoculus*. The single specimen 138 mm., from off Tortugas is in poor condition, and no Gulf specimens of comparable size are available for comparison. Hence its proper placement is not altogether certain. However, its determinable characters agree well with similar-sized specimens of *albidus* and it is included in its account.

This species evidently has a different vertical distribution, living in deeper water than the other common species (*bilinearis*) that occurs in its geographic range. However, their vertical ranges overlap and two of the constituent samples of *albidus* examined (157755–6) were separated from containers that included also specimens of *bilinearis*, taken at Albatross Stations 2242 and 2248, off Long Island in 58–67 fathoms. These two composite lots of both species consist of small specimens 36–66 mm.

Comparison.—This species differs sharply from *bilinearis* in the number of gill rakers (tables 1–3). There are no intergrades in the numbers on the lower limb in the many specimens of *bilinearis* examined. The gap between the frequency distributions of the two species becomes wider when the total number on the outer arch is used as the basis of comparison. Other diverging characters that intergrade more or less between those two species are as follows: *albidus* averaging a longer head, larger eye, shorter pectoral and fewer rays in the two dorsals and anal.

This species is compared with *magnoculus* under the account of the latter (p. 195).

To compare them with *albidus* three European specimens were examined in the U. S. National Museum, with the following standard lengths: Bergen (17372, 730 mm.); Livorno (28471, 351 mm.); Bay of Naples (48446, 111 mm.). The counts and proportional measurements of the

Norwegian specimen are as follows: Dorsal 11; 39. Anal 38; pectoral 14; gill rakers 2+8; scales about 170. Caudal 10.2; pectoral 15, ventral 12.7, head 28.6, maxillary 14.1, snout 10.4, eye 3.9, depth 16.5. The same data for the two Italian specimens, those for the larger specimen stated first and separated by a hyphen where they differ, are as follows: D. 9–10; 39–38. A. 38; P. 14; gill rakers 2+8–9; scales about 153–157. Caudal 11.3–13.1, pectoral 16.1–16.2, ventral 15.6–19.7, head 29.8–32.5, maxillary 15.2–17.1, snout 9.8–12.6, eye 5.8–6.2, depth 17.3–18.4 The gill raker count of the European specimens is therefore about the same as in *albidus;* but the scales in these 3 specimens are more numerous, about 153–170 in the three European specimens and about 129–144 in 6 specimens of *albidus*. The two Italian specimens have fewer rays in the first dorsal and a longer head and shorter pectoral than *albidus*. The first dorsal count of the Norwegian specimen falls at the lower end of the distribution of *albidus;* while in proportional measurements the two nearly comparable specimens, 730 mm. as compared with 626 mm. in standard length of *albidus* (see tables 8–15), do not differ to a notable extent, the Norwegian population perhaps averaging a shorter pectoral, head, and maxillary. While it would be well to compare in detail the European *Merluccius* populations from the Atlantic and Mediterranean coasts, it is evident that the American *albidus* differs in having fewer scales and at least averages more rays in the first dorsal.

Nomenclature.—Now that two common and easily separable species of *Merluccius* are proved to exist on the Atlantic coast of the United States, the question arises of a name to apply to either species.

Mitchill proposed two names, *Stomodon bilinearis*, 1814, and *Gadus albidus*, 1818, for specimens that he presumably thought to represent two distinct species. These two names have been synonymized by later authors and the older name, *bilinearis*, has been applied to what they thought to be a single species of whiting on the coast of New York and adjacent areas in the western Atlantic. However, Mitchill's original accounts contain some clues by which his names may perhaps be identified with the two common species here distinguished.

Mitchill (1914, see citation below), under his account of (*Stomodon*) *Merluccius bilinearis*, states as follows: ". . . a hard featured fish bought in the New York market, Nov. 4, 1813 . . . Eyes large . . ." Under his account of (*Gadus*) *Merluccius albidus* (above citation), he states: "The individual from which I make the present description, was taken in the Atlantic Ocean, a few leagues from Sandy Hook, on what are called the Sea-bass banks . . . Eyes very large . . ." Mitchill's accounts then contrast two factors by which our two species are distinguishable. One is the habitat. A fish bought in the New York market in those days, on which Mitchill based his *bilinearis*, more likely than not was taken inshore, while the specimen on which *albidus* was based was taken offshore. Also, according to the original accounts as quoted, the two species presumably differ in the size of the eye, the offshore species having a larger eye. These two correlated items are the same as characterize in part the two species here distinguished from the Atlantic coast of the United States, and these two species are therefore here designated by Mitchill's names, *bilinearis* and *albidus*, respectively. While the evidence is not conclusive, especially in the absence of gill raker counts, it is about as good as that on which the proper determination of many names by early authors, are based.

Merluccius magnoculus, new species

Description.—Gill rakers 2−3+7−9 or 9–11 in combined number. D. 11–13 ; 36–42. A. 37–41. Pectoral rays modally 13, varying 12–15. Head rather long, 29.6–31.3; pelvic and pectoral rather short, 13.4–15.9 and 15.8–19.2, respectively; eye averaging larger than other species, 6.1–8.2; maxillary and snout long; body rather deep (measurements here given referring to same 20 specimens, 189–290 mm. in standard length; for their changes with growth and other measurements see tables 8–15). Scales about 124–130 (in 2 specimens). Cheek, preopercle, and interopercle probably almost altogether scaled (scalation nearly obliterated or very incompletely preserved in all specimens examined and its extent not altogether certain). Peritoneum solid black; caudal emarginate (peritoneum and caudal shape the same in all specimens examined, including the 2

smallest 210 and 213 mm., 191 and 189 mm. in standard length, respectively).

Holotype.—U. S. Nat. Mus. 157757. Oregon Station 270; lat. 29°23′ N., long. 87°25′ W.; off Pensacola, Fla.; 220 fathoms; 313 mm.

Paratypes.—Off the following localities, all taken by the Oregon, except 3 specimens taken by the Albatross as noted below. Cape San Blas (157760) and Pensacola (144303, 3 specimens 278–305 mm. taken by the Albatross; 157761–2), Florida. Mississippi Delta (157758, 157763), Louisiana. Padre Island (157759), Texas. Total examined 31 paratypes 210–501 mm., taken in 150–305 fathoms.

Comparison.—This species is very near the Atlantic *albidus*, both nearly agreeing in the gill raker count, and the eye is relatively large in both. The two evidently constitute a pair of related allopatric populations. They might possibly be treated as coordinate geographic subspecies. However, the degree of divergence between them is of species rather than subspecies magnitude.

The two species diverge chiefly in 3 characters, *magnoculus* having a longer head and shorter pelvic and pectoral (tables 8–10). The relative length of the head and pelvic changes with growth. When divided into size groups, as in the tables, the determined data are not as extensive as might be desired, as the number of specimens in every size group is rather limited; nevertheless they are fairly sufficient to draw acceptable conclusions. The relative length of the pectoral apparently changes little with growth, if any.

The two species overlap somewhat in all three characters, but the degree of divergence in every one is evidently of species magnitude, even when the data are arranged in wide size groups, as in tables 8–10. The extent of divergence is evidently greater when the comparison is made separately for the several size groups. The degree of divergence also seems to be of nearly the same magnitude in all three characters.

This species also has a longer maxillary (table 11). The degree of divergence also seems to be of species magnitude, although perhaps slightly less than in the three foregoing characters.

Other moderately or slightly diverging characters, perhaps named in order of magnitude of divergence, are as follows: *magnoculus* averaging a longer snout, fewer pectoral rays, a larger eye, more rays in the first dorsal and anal, and fewer rays in the second dorsal. All in all, the treatment of the two diverging allopatric populations as full species seems justified.

On general view the eye in *magnoculus* appears strikingly large. However, after measuring a number of specimens and tabulating the results, as in table 13, it is found that this measurement overlaps rather widely with related species, although the averages appear to be moderately higher in *magnoculus* when compared size for size.

Merluccius polylepis, new species

Merluccius gayi Gunther (not Guichenot), Rept. Voy. *Challenger*, Shore Fishes, p. 22, 1880 (Gray Harbor, Messier Channel, Straits of Magellan)

Merluccius australis Norman (in part), Discovery Rept. 16: 48, 1937 (based in part on specimens recorded by Gunther, as cited above)

Description.—Gill rakers 3−4+10−11, or 13–15 in total number on first gill arch. D. 11–12; 43–45. A. 42–45. Pectoral rays 13–15, the mode possibly at 14. Proportional measurements of head, pelvic, pectoral, and eye rather low in numerical value;

FIGURE 2.—*Merluccius polylepis;* from the holotype; U. S. Nat. Mus. 157764; taken at Castro, Chile (42°29′ S., 72°46′ W.); 314 mm. Drawn by Mildred H. Carrington.

27.5–29.9, 11.6–13.8, 17.4–19.1, and 4.7–5.4, respectively (measurements of 4 specimens 281–325 mm. in standard length; for size differences and other measurements see tables 8–15). Scales about 182–186 (in 4 specimens). Color of peritoneum variable, very dark, moderately dark, or dusky with a silvery wash, speckled profusely with small dots of variable size and of a more intense pigment than ground color, the speckling strongly marked in specimens with a lighter peritoneum, rather faint in those with a dark peritoneum. Caudal rounded in 2 specimens 281–283 mm. in standard length, truncate or nearly so in 2 specimens 323–325 mm.

Holotype.—U. S. Nat. Mus. 157764. Castro, Chile (42°29′ S., 72°46′ W.); M. J. Lobell and others; January 22, 1945; 314 mm., 283 mm. in standard length.

Paratypes.—Castro, Chile; January 20, 1945; 308 mm., 281 mm. in standard length (157765). Puerto Auchemo, Chile (43°01′30″ S., 72°50′ W.); January 24, 1945; 2 specimens 358–359 mm., 323–325 mm. in standard length (157766). The 3 paratypes were obtained by the same collectors as the holotype.

Comparison.—This species about agrees with *hubbsi* in the number of gill rakers, perhaps averaging slightly lower numbers (tables 1–3). It differs from *hubbsi* in having larger numbers of rays in the second dorsal and anal (tables 5–6). It further differs from *hubbsi* in having more numerous scales, about 182–186 in 4 specimens of *polylepis* as compared with about 138–144 in 2 specimens of *hubbsi*. In practice the scale count in *Merluccius* is not an easy character to use with precision as discussed above. However, the difference between the two species in the number of scales is pronounced, and to a certain extent it may be detected on superficial examination without actually making the count. This species possibly will be found to average fewer pectoral rays than *hubbsi*, but the divergence evidently will be of minor degree (table 7). The two species apparently do not differ much in proportional measurements (tables 8–15), possibly some average difference will be found on examination of numbers of specimens in comparable size groups.

In its high number of rays in the second dorsal and anal, and scales, *polylepis* differs, at least on the average from all other species here treated. It is easily distinguished from *gayi*, which occurs in the same region with it, by these characters in combination with its comparatively low gill raker count.

Norman (1937: 48) who examined specimens from the Straits of Magellan that presumably belong to this species, identified them with *australis* of Hutton which was originally described from New Zealand. Regrettably no specimens from New Zealand are available to me for comparison, but the Chilean population evidently differs specifically from that of New Zealand. The fish fauna of New Zealand, by and large, is very different from that of the Pacific coast of South America including Chile. On zoogeographic grounds it is therefore improbable that the two populations are identical, although it is not impossible that both belong to the same species. Furthermore, the Chilean population evidently differs in having a greater number of dorsal and anal rays. The ranges of these two counts given by Hutton (1872: 45) and Waite (1911: 182) are: 36–41 in both fins, whereas the 4 Chilean specimens examined during this study have D. 43–45, A. 42–45.

Gunther (1880: 22) records D. 43–44, A. 43 for his specimens from Gray Harbor, Magellan Straits, which about agrees with our 4 Chilean specimens. That the Chilean population has a notably high second dorsal and anal count is shown by comparing the counts of the 4 specimens examined with the 7 other American species (tables 5–6). The second dorsal count falls out of the range of 6 species, except *productus;* while the anal count falls out of range of 4 species, except *bilinearis*, *productus*, and *gayi*. Even as compared with the 4 exceptional species mentioned the counts in the Chilean specimens average distinctly higher. In sum, judged by our counts compared with those of the three authors discussed, taken in conjunction with the known facts of zoogeography, it is highly probable that the Chilean population is sufficiently divergent to be recognized nomenclatorially, as is done here.

Norman (1937: 49) examined 3 specimens from New Zealand and the Magellan Straits and records the entire range of his counts as D. 36–43 and A. 36–42. However, he does not break down the counts by locality to show any possible population difference, and his account is of no help in deciding the question.

Merluccius hubbsi Marini

Merluccius hubbsi Marini, Rev. Soc. Argentina Cien. Nat. 11: 322, photo., 1933 (Argentina). Norman, Discovery Rept. 16: 45, fig. 20A, 1937 ("Brazil to the Straits of Magellan").

Description.—Gill rakers 3–5+9–12 or 13–16 in combined number. D. 11–14; 37–40. A. 37–40. Pectoral rays modally 15, nearly as often 14, sometimes 16. Measurements rather medium, on the whole: head 28.4–29.0, pelvic 16.7–17.5, pectoral 19.9–20.0 (measurements of 2 specimens 177–209 mm. in standard length; for growth changes and other measurements see tables 8–15). Scales about 138–144 (in 2 specimens). Peritoneum in small specimens with a silvery color densely covered with brown spots of various sizes, small to minute; with growth, the silvery ground color becoming suffused with brownish or changing to brownish, the small spots persisting.

The distal margin of the caudal is rounded in specimens examined up to 209 mm. in standard length. In the next size available, a specimen 412 mm., the margin is somewhat frayed but appears to have been rounded also or truncate. Dr. Robert R. Miller kindly examined at my request a paratype of this species (UMMZ 95461) 750 mm. in standard length. He reports that the caudal in this specimen is somewhat frayed, but that apparently it is, and has been normally, moderately emarginate. Marini (1933) and Norman (1937, above citations) published illustrations showing a moderately or slightly emarginate caudal, but the sizes of the specimens illustrated are not given. The size at which the caudal becomes emarginate in this species still remains to be determined; but it evidently becomes so at a larger size than in the other species here treated with the possible exception of *polyepsis*.

Specimens examined.—Argentina off the following localities: Punta San Roque (103768, 236 mm.; 161491, 452 mm., 52 fathoms). Puerto San Julian, 51 fathoms (77291, 40 specimens, some paratypes of *hubbsi*, about 40–200 mm.). Also, 15 specimens about 90–140 mm., from "Patagonia" without any definite locality (43388). These 15 specimens are in very bad condition. Their data are not included in this account but their gill raker counts about agree with the other specimens of *hubbsi*.

Comparison.—This species from the Atlantic from the Pacific coast, has its gill raker count rather intermediate between the two primary *bilinearis* from the northwestern Atlantic, as the groups of species separated in the key, but nearer the second group that includes species with the greater number of gill rakers. It is compared above with *polylepis* under the account of that species.

While it about agrees with *polylepis* in the number of gill rakers, taking its character pattern as a whole, *hubbsi* is structurally nearest to *bilinearis* from the northwestern Atlantic, as the two species appear to intergrade more or less in every character studied. The greatest divergence between these two species is shown by the gill raker counts (tables 1–3), and though they intergrade in this character also, the degree of divergence is of species magnitude. In the number of rays in the anal and second dorsal (tables 5–6) the degree of divergence between *hubbsi* and *bilinearis* is of subspecies magnitude. This species also averages a longer head, larger eye, and shorter ventral and pectoral than *bilinearis* (tables 8–11 and 13), but the degrees of intergradation in these characters seem to be considerable.

Structurally *hubbsi* is farther removed from *gayi* which lives on the southeastern Pacific coast than from the geographically remoter *bilinearis*. The gill raker count does not intergrade between the two species in the samples examined (tables 2–3), there is even a slight gap as compared with the subspecies *gayi*. In the pectoral count (table 7) *hubbsi* overlaps with both subspecies of *gayi*, but the divergence is about of species magnitude as compared with *peruanus* and subspecies magnitude as compared with the subspecies *gayi*. In the number of rays in the first dorsal (table 4) the degree of divergence appears to be of subspecies magnitude as compared with both subspecies, but it is of greater extent as compared with *peruanus*. In the number of rays in the second dorsal (table 5) the degree of divergence as compared with the subspecies *gayi* appears to be of about subspecies magnitude, but it is considerably less than that as compared with *peruanus*. In the number of anal rays (table 6) *hubbsi* is intermediate between the subspecies *gayi* and *peruanus*, averaging fewer rays than in the former and more than in the latter, but in either case the divergence is less than

of subspecies magnitude. This species also seems to average a shorter head, maxillary, snout, and pectoral, and a longer pelvic, at least in the smaller specimens as compared with *peruanus;* but not enough specimens in the several size groups are available to determine the extent of divergence in proportional measurements.

Merluccius bilinearis (Mitchill)

Stomodon bilinearis Mitchill, Fishes of New York, p. 7, 1814 (original publication not examined; an example of the annotated copy edited and printed by Gill, 1898, examined).

Description.—Gill rakers 2—6+11—17 or 15–22 in total number on first gill arch. D. 11–14; 37–42. A. 39–42. Pectoral rays modally 15, nearly as often 14, varying 13–17. Head short 25.4–28.1; pelvic, pectoral and caudal rather long 16.5–19.6, 19.7–24.1, and 11.6–14.7, respectively; eye averaging smaller than in the other species, 4.9–7.0; snout, maxillary, and depth measurements rather low (given measurements of 26 specimens 181–294 mm. in standard length; for their change with growth and other measurements see tables 8–15). Scales about 112–130 (in 11 specimens). Peritoneum ground color silvery in small specimens, brownish of variable shades of intensity in large fish, at all sizes stippled and finely spotted with black dots.

Of 25 of the larger specimens examined for the caudal that appear to have this fin uninjured or nearly so, 4 specimens 210–238 mm. in standard length have it rounded; in 8 specimens 135–278 mm., it is truncate; in 12 specimens 238–442 mm., it is emarginate. It is evident that the length at which the caudal becomes emarginate differs greatly with the individual. Perhaps it may be said tentatively, that on an average it becomes emarginate at about 260 mm. in standard length.

Neotype.—As discussed on page 193, it seems desirable to designate a neotype for this species. Therefore, the following specimen is hereby set aside as the neotype of *bilinearis:* U. S. Nat. Mus. No. 39935; Oyster Bay, Long Island, N. Y.; E. G. Blackford; January 25, 1889; 265 mm., 236.5 mm. in standard length.

Other specimens examined.—From or off the following localities. Halifax market (21016). Eastport (13888), South Harpswell (70350–1) and Portland (154899), Maine. Georges Bank (21696), Gloucester (83926, 148176), Cape Cod Light (31560, 33431), Nauset Light (31561), Woods Hole (13007, 49231) and Vineyard Sound (37367, 54918, 54924), Mass. Newport (75007–8, 75018) and Narragansett Bay (25806), R. I. Cornfield Light (58508) and Branford Beacon (92634), Conn. Great South Bay (37014) and Long Island (31846, 33033–6 inclusive, 33344, 44265, 45916, 45918), N. Y. Brigantine (118227) and Wildwood (118224–5), N. J. Brandywine (118226), Del. Barren Island (91275) and Cape Henry (91274), Chesapeake Bay. Cape Fear (155474), N. Car. Total examined, including the neotype, 433 specimens 47–487 mm. Depth records, available for 17 of the 40 constituent samples examined, range 13–198 fathoms.

Comparison.—Structurally this species is nearest *productus* from the west coast of the United States, and the differences between them are discussed under that species. The morphological and distributional differences between this species and *albidus*, its common congener that occurs in the same geographic area with it, are discussed under the account of that species. The differences between *bilinearis* and *hubbsi* a closely related species on the Atlantic coast of South America are discussed under the latter.

As compared with *gayi* from the Pacific coast of South America, the extent of divergence differs with the subspecies somewhat as in the comparison between *gayi* sensu lato and *productus* as discussed on page 200. This species differs from both subspecies of *gayi* in having a shorter head and longer pelvic (tables 8–9). The extent of divergence in these two measurements is greater in the smaller specimens and probably greater as compared with *peruanus* than with the subspecies *gayi;* but so far as the specimens measured indicate, it seems to be of species magnitude.

In the number of anal rays (table 6) *bilinearis* diverges from the subspecies *peruanus* to a degree that is about of species magnitude, although they overlap in this character; but the anal rays in the subspecies *gayi* averages only moderately lower than in *bilinearis.* In the number of pectoral rays (table 7) the divergence as compared with *peruanus* is about of species magnitude, although the intergradation is greater than in the anal count; while as compared with the subspecies *gayi*

it is only of subspecies magnitude. In the number of rays in the first dorsal the divergence is of subspecies magnitude as compared with both subspecies of *gayi* sensu lato, but the extent of intergradation is greater as compared with the subspecies *gayi*. In the number of second dorsal rays (table 5) the divergence as compared with *peruanus* is of subspecies magnitude, while as compared with the subspecies *gayi* it is less than subspecies magnitude. On the other hand, in the total number of gill rakers the divergence as compared with the subspecies *gayi* is of subspecies magnitude, while as compared with *peruanus* it is less than that magnitude. This species also averages a shorter pectoral, maxillary and snout than *gayi* sensu lato (tables 10–12). These characters seem to intergrade more or less, especially in the larger size group, and the intergradation is probably greater as compared with the subspecies *gayi*, but the specimens examined are not numerous enough to determine the extent of divergence or intergradation with precision.

A sample with high gill raker count.—One constituent sample examined has a markedly high gill raker count. It is a lot of 277 specimens taken at Wildwood, N. J., U. S. Nat. Mus. 118224. This lot is contrasted in tables 1–3 with the combined count of all other 39 constituent samples taken north and south of Wildwood, comprising 156 specimens, including a smaller lot of 9 specimens from Wildwood. The relatively high count of this constituent sample as compared with the combined data of all other specimens is notable and worthy of special mention for this reason. Treatment of the two sets of data by statistical methods that are often applied to biological data, will likely show a "significant" difference between them. However, the biological significance of this difference is not obvious, and it is doubtful whether it has such a significance.

Merluccius productus (Ayres)

Merlangus productus Ayres, Proc. California Acad. Nat. Sci. 1: 64, 1855 (San Francisco market).

Homalopomus trowbridgii Girard, Proc. Acad. Nat. Sci. Philadelphia 8: 132, 1856 (Astoria, Oregon).

Description.—Gill rakers 4−5+13−18 or 17–22 in total number on first gill arch. D. 10–12; 39–44. A. 41–44. Pectoral rays predominantly 16, often 14 or 15. Head and pelvic rather short, 26.4–28.6 and 12.1–14.1, respectively; pectoral rather long 20.2 (in one specimen); eye, maxillary, snout, and depth measurements rather low (measurements here given of 3 specimens 225–272 mm. in standard length; for their change with growth and other measurements see tables 8–15). Scales about 147–166 (in 7 specimens). Peritoneum in small specimens silvery stippled and finely spotted with dark dots of two general sizes; in the larger fish becoming grayish blotched with brownish or brownish washed with grayish, the small dots rather faint or absent. The caudal is more or less emarginate in 6 specimens 225–446 mm. in standard length; it is damaged in other specimens examined including the smaller fish.

Specimens examined.—Puget Sound (27295), Seattle (26638, 60679), and Chinook (67303), Wash. Astoria (285, type of *trowbridgii;* 37316) and off Seal Rock (54608), Oreg. San Francisco (529, type of *productus*), La Jolla Point (77439; 280 fathoms), San Diego (41863), San Diego Bay (54815) and Point Loma (77440; 241 fathoms), Calif. Total examined 12 specimens about 125–520 mm. in 12 constituent samples, including the holotypes of *productus* and *trowbridgii*. Depth records 241–280 fathoms, are available for only 2 of the constituent samples as indicated above.

Comparison.—Structurally this species is nearest *bilinearis*, most nearly agreeing with it in the gill raker count and the head length. It differs chiefly in having a shorter pelvic fin and a higher scale count. The change with growth in the pelvic and the difference in its length between the two species are shown in table 9. The relative length of the pelvic decreases somewhat with growth; but even when the data for all sizes are lumped, as in table 9, there still remains a gap between the two species for this character. The scale count is not a good character to use, because it cannot be determined with anywhere near precision as discussed above. Nevertheless, the divergence seems to be considerable, about 147–166 rows in 7 specimens of *productus* as compared with 112–130 rows in 11 specimens of *bilinearis*. Other divergent but widely overlapping characters are as follows: *productus* averaging higher gill raker, anal, pectoral, and second dorsal counts and a lower first dorsal count. The head and maxillary seem to average longer and shorter, respectively.

The differences between *productus* and *angustimanus* are discussed under the account of the latter species.

The divergence between *productus* and *gayi*, sensu lato, is not as pronounced as its divergence from *angustimanus*, and it differs with the subspecies, diverging in most characters, excepting the gill raker count, to a greater extent as compared with the subspecies *peruanus* rather than the subspecies *gayi* which occurs farther south. It differs from both subspecies in the following characters, perhaps named roughly in order of extent of divergence: *productus* averaging a greater number of anal and second dorsal rays (tables 5–6) and scales, a shorter head, maxillary, snout, pelvic, and pectoral (tables 8–12). As compared with the subspecies *peruanus* it does not intergrade in the number of anal rays, and the divergence in the head length and the number of rays in the second dorsal is also of species magnitude in the specimens examined. They intergrade to some extent in the number of dorsal rays, but the divergence is still of species magnitude. As compared with the subspecies *gayi* it intergrades in the number of anal rays, but the degree of divergence is of species magnitude; while the extent of divergence in the number of second dorsal rays and the head length is evidently not more than subspecies magnitude, if that much. The divergence in the length of the maxillary and snout seems to be of species magnitude, or nearly so, compared with *peruanus*, and not more than subspecies magnitude, if that much, compared with the subspecies *gayi*. The divergence in the pelvic and pectoral length is moderate or slight; possibly of subspecies magnitude as compared with *peruanus* and less than that magnitude as compared with *gayi*. On the other hand, the number of gill rakers in *productus* is very nearly the same as in the subspecies *peruanus*, and less on the average than in the subspecies *gayi*, although the difference is of very moderate extent.

There appears to be a difference in the scale count: about 147–166 in 7 specimens of *productus* as compared with about 141 in 1 specimen of *peruanus* and about 124–144 in 11 specimens of *gayi;* but the scalation is incompletely preserved in all specimens examined and this character cannot be used with precision as discussed above.

Merluccius angustimanus Garman

Merluccius angustimanus Garman, Mem. Mus. Comp. Zool. 24: 183; pl. 41, figs. 1–1a, pl. 82, fig. 1, 1899 (off Point Mala, Gulf of Panama).

Description.—Gill rakers 3–5+12–14 or 16–18 in total number on first gill arch. D. 11–12; 36–39. A. 37–40. Pectoral rays 15–17. Head and pectoral long, 31.0–32.8 and 21.3–23.3, respectively; pelvic (14.0–14.5) and other measurements about medium (the measurements here given of 4 specimens 235–289 mm. in standard length, for their change with growth and other measurements see tables 8–15. Scales about 130–149 (in 4 specimens). Peritoneum dark brown or brownish with a grayish or silvery cast; stippled and finely spotted with dots, separable approximately into two sizes, darker than ground color, well-marked in specimens with a light peritoneum, faint in those with a dark peritoneum. The caudal is truncate in 1 specimen 161 mm. in standard length and emarginate in 3 specimens 257–289 mm.; it is damaged in the other 4 specimens examined.

Specimens examined.—Del Mar, Calif., 25 miles offshore; approximately 32°57′ N., 117°33′30″ W.; mid-water trawl 640 meters over 580 fathoms (Scripps Institution of Oceanography H50–290). Off Bahia de Ballenas, west coast of Lower California; 48 fathoms; Albatross Station 2834 (46459). Off Santo Domingo, west coast of Lower California; mid-water trawl, 1,040 fathoms over 2,000 fathoms (SIO H51–87). Townsend Expedition, 1911 (87576; 2 specimens 161–162 mm.; no definite locality recorded in catalog, most probably taken in Gulf of California). Off Point Mala, Gulf of Panama (2 cotypes 177 mm.; 57873, 127 fathoms, Albatross Station 3387; 120424, 286 fathoms, Albatross Station 3385). Total examined 8 specimens 161–322 mm., including 2 cotypes; 3 taken by the Albatross in 48–286 fathoms; 2 in the collection of the Scripps Institution of Oceanography taken by mid-water trawls at 350–1,040 fathoms; 2 without definite data.

Comparison.—This species is close to *gayi* from the Pacific coast of South America. They differ chiefly in the numbers of gill rakers (tables 1–3). Although they intergrade in these counts, the divergence judged by the samples examined seems to be of species magnitude. It averages a greater number of rays in the first dorsal (table 4), the degree of divergence being perhaps of subspecies

magnitude. In the number of second dorsal and anal rays (tables 5–6) it diverges from the subspecies *gayi*, perhaps to a subspecific degree of magnitude; but its divergence from *peruanus* in these two counts evidently is slight, if any. It nearly agrees in the number of pectoral rays with both subspecies. It does not differ appreciably in proportional measurements, at least as compared with *peruanus*.

The relationship between *angustimanus*, *peruanus*, and the subspecies *gayi* with respect to the number of gill rakers is similar to that between *Symphurus civitatum*, *S. plagusia*, and *S. tessellata* with respect to the number of fin rays that I treated in another publication (1951). Among the three populations of *Symphurus* the fin ray numbers average lowest in *civitatum*, highest in *tessellata*, and are intermediate on the average in *plagusia*. The frequency distributions of these numbers overlap considerably as between *tessellata* and *plagusia* which are therefore, treated as coordinate subspecies. On the other hand, the change in *civitatum* is more abrupt, the intergradation between it and *plagusia* is of a considerably lesser degree. Therefore, *civitatum* is treated as a full species. With respect to the number of gill rakers a similar situation exists among the three populations of *Merluccius* concerned; but the degrees of divergence differ. Here also *angustimanus* averages the lowest number of gill rakers, the subspecies *gayi* the highest, and the number in *peruanus* is intermediate. The divergence of *angustimanus* from the other two populations is comparatively abrupt, and considering its extent it is properly treated as a full species because of this difference. However, the divergence between *peruanus* and *gayi* in the gill raker count is less than that of subspecies magnitude. In this respect they differ in degree from the relation between *Symphurus plagusia* and *S. tessellata* with respect to the number of dorsal and anal rays. The two *Merluccius* populations are treated as subspecies because of their divergence in other characters than the gill raker numbers, as discussed later under the account of *peruanus;* but this is beside the point in the present connection.

As compared with *productus*, the common species that occurs north of its geographic range, *angustimanus* differs chiefly in four characters that show a divergence of species magnitude, namely it has a smaller number of gill rakers and anal and second dorsal rays and a longer head. The head length (table 8) is 25.5–28.6 in 11 specimens of *productus* 113–459 mm. in standard length and 31.0–33.3 in 8 specimens of *angustimanus* 145–289 mm. In the specimens examined the proportional length of the head does not intergrade even when all measurements for all sizes are lumped together. When the measurements are divided by size groups, as in table 8, the extent of divergence in comparable size groups is increased. In the number of anal rays (table 6) there is no intergradation between the specimens examined. The number of gill rakers on the lower limb and the total number (tables 2–3), as well as the number of dorsal rays (table 5) intergrade slightly between these two species, but the degree of divergence in the samples examined is of species magnitude.

The two species also seem to differ in the number of scales, 147–166 in 7 specimens of *productus* as compared with 130–149 in 4 specimens of *angustimanus;* but this is an unsatisfactory character to use.

This species also has a longer snout, maxillary, pectoral, and pelvic than *productus* (tables 9–12). The extent of divergence in the pectoral and pelvic measurements is not obvious from the few data determined, but it might prove to be considerable Two other characters of less than diverging subspecies magnitude are as follows: *angustimanus* averaging more rays in the first dorsal and pectoral (tables 4 and 7). Altogether *angustimanus* and *productus* constitute two well-divergent species.

Merluccius gayi (Guichenot), sensu lato

Description.—Gill rakers 3−6+13—19 or 17–25 altogether on first gill arch. D. 10–13; 36–42. A. 36–42. Pectoral rays 15–18. Head moderately or notably long (head and other measurements differ to some extent with subspecies; see their accounts and tables 8–15). Scales about 124–144. Peritoneum variable, moderately light to dark, punctate with small dots moderately differing in size.

Comparison.—This species is here subdivided into two subspecies that differ considerably in comparison with the other species of the genus

and with each other. On the one hand *gayi* sensu lato is nearest to the geographically adjacent *angustimanus*, they overlap slightly in the number of gill rakers, the chief character that separates them, and both have a comparatively long head, although the head length in *gayi* possibly also differs with the subspecies, perhaps being shorter in the subspecies *gayi*. On the other hand, *gayi* is near to *bilinearis* which lives in the northwestern Atlantic. It is also near *productus* from the northeastern Pacific. The differences between *gayi* and the above three species are discussed under their accounts. It is also compared above with *polylepis* (p. 196), its more remote congener that lives in the same region with it, and with *hubbsi* from the southwestern Atlantic (p. 197).

The pelvic length in *gayi*, which constitutes the chief character that separates *bilinearis* and *productus*, is intermediate in measurements between those two species.

Merluccius gayi peruanus, new subspecies

Merluccius gayi Evermann and Radcliffe, Bull. U. S. Nat. Mus. 95: 158, 1917 (Paita and Callao, Peru). Hildebrand, ibid. 189: 157, 1946 (account based on same specimens forming basis of present account, see below).

Description.—Gill rakers 4–6+13–17 or 17–23 in total number of first gill arch. D. 11–12; 36–40. A. 36–39. Pectoral rays most predominantly 16–17, varying 15–18. Head and pectoral rather long, 30.6–31.5 and 23.0–23.1, respectively; pelvic (14.6–14.7) and other measurements rather medium (the given measurements of 2 specimens 240–370 mm. in standard length; for their change with growth and other measurements see tables 8–15). Scales about 141 (in 1 specimen). Peritoneum brownish with a grayish cast or grayish with a brownish cast, stippled and finely spotted with dark dots of approximately two sizes. Caudal emarginate in 7 specimens 138–370 mm. in standard length; damaged in the other 4 specimens examined. The caudal in this subspecies apparently becomes emarginate at a smaller size than in the other species examined.

Holotype.—U. S. Nat. Mus. 77727. Paita, Peru; R. E. Coker; 417 mm., 370 mm. in standard length.

Paratypes.—From or off the following localities on the coast of Peru: Chimbote Bay (128181, from stomach of yellowfin tuna), Callao (77525, 77539), Cañete (128180). Total examined, including the holotype, 11 specimens 156–417 mm. in 5 constituent samples. Depth records for the samples examined are unavailable.

Comparison.—The character showing the greatest divergence between the Peruvian and Chilean populations of *gayi* refers to the number of anal rays (table 6). This divergence is about of subspecies magnitude, although the two samples compared are not altogether adequate. Nearly the same degree of divergence is shown by the number of dorsal rays (table 5). The Peruvian population averages lower gill raker counts (tables 1–3), but the divergences are less than subspecies magnitude. A comparison of the measurements of 3 Chilean specimens 308–389 mm. in standard length with a Peruvian specimen 370 mm. (tables 8–15), indicates that the latter population probably averages a longer head and maxillary. Taking everything into consideration it seems that the two populations are best treated as distinct subspecies.

Merluccius gayi gayi (Guichenot)

Merlus gayi Guichenot, *in* Gay, Historia fisica y politica de Chile, vol. 2, p. 32, 1948 (Chile). Guichenot, *in* Gay, Atlas de la historia fisica y politica de Chile, vol. 2, ictiologia pl. 8, fig. 2, 1854 (Chile).

Description.—Gill rakers 3–6+14–19 or 18–25 in total number on first gill arch. D. 10–13; 37–42. A. 39–42. Pectoral rays 15–17. Head and pectoral moderately long, 28.4–29.8 and 19.9–21.0, respectively; pelvic (13.5–14.6) and other measurements medium on the whole (given measurements of the 3 smallest specimens examined 308–389 mm. in standard length; for growth changes and other measurements see tables 8–15; statement regarding proportional measurements is tentative as no smaller specimens of this subspecies are available for comparison). Scales about 124–144 (in 11 specimens). Peritoneum variable, light yellowish to dark brown, rather thickly sprinkled with small dark dots varying moderately in size. Caudal emarginate in all specimens examined, the smallest 341 mm.

Specimens examined.—Collected on the coast of Chile by M. J. Lobell and others, between south latitudes 26°21′ and 45°10′30″ as follows, depth records not available. Chanaral de las Animas Bay (157768), Huasco Bay (157770), Coquimbo Bay (157771), Isla Santa Maria, Norte (157772),

Queule (157773), Puerto Montt (157769), Huichas Island (157767). Total examined, 15 specimens 341–637 mm., 308–581 mm. in standard length.

Comparison.—This subspecies is compared above with *peruanus* under its account.

Nomenclature.—Two species of *Merluccius* occur on the coast of Chile, but it is not possible to tell definitely from Guichenot's accounts which one of the two species he described. His description might apply to both species. His plate taken in connection with the location of the fish shows that his species belongs to *Merluccius;* but the figure is obviously erroneous in detail and does not apply well to either species. Dr. Leon Bertin who very kindly examined the type of *gayi* at the Paris Museum, reports that it is now in bad condition and the number of gill rakers, the most crucial distinguishing character, is not now well determinable. Judged by the specimens examined during this investigation, it seems that the present species is the more common one on the coast of Chile; therefore, I assume that this is the species which Guichenot described, while the other Chilean species is described above under the name of *polylepis.*

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TABLES

TABLE 1.—*Frequency distribution of the number of gill rakers on the upper limb of the first gill arch in American species of* Merluccius

[Tubercles are not included in count. Counts of gill rakers in *polylepis, productus, angustimanus, peruanus,* and *gayi* were made on both sides of each specimen and entered independently in this and the following 2 tables, as though they were taken from 2 specimens. Percentage numbers of the frequencies for every species are given in the second line in this and the following 6 tables for convenience in computing the indices of intergradation and divergence as discussed in the text.]

Species and subspecies	Distribution					
	1	2	3	4	5	6
albidus	4	32	2			
	10.5	84.2	5.3			
magnoculus		31	1			
		96.9	3.1			
polylepis			2	6		
			25.0	75.0		
hubbsi			12	28	2	
			28.6	66.6	4.8	
bilinearis		1	14	261	153	4
		.2	3.2	60.3	35.3	.9
productus				12	12	
				50.0	50.0	
angustimanus			4	11	1	
			25.0	68.8	6.3	
peruanus				9	12	1
				40.9	54.6	4.5
gayi			1	8	18	3
			3.3	26.7	60.0	10.0
bilinearis						
Wildwood U. S. Nat. Mus. 118224			8	158	109	2
			2.9	57.0	39.4	.7
All other samples		1	6	103	44	2
		.6	3.8	66.1	28.2	1.3

TABLE 2.—*Frequency distribution of the number of gill rakers on the lower limb of the outer gill arch in American species of* Merluccius

Species and subspecies	Distribution												
	7	8	9	10	11	12	13	14	15	16	17	18	19
albidus		30	8										
		79.0	21.0										
magnoculus	1	27	4										
	3.1	84.4	12.5										
polylepis				5	3								
				62.5	37.5								
hubbsi			1	10	26	5							
			2.4	23.8	61.9	11.9							
bilinearis					3	13	156	181	67	9	4		
					.7	3.0	36.0	41.8	15.5	2.1	.9		
productus							1	2	5	7	5	3	
							4.4	8.7	21.7	30.4	21.7	13.0	
angustimanus						6	8	2					
						37.5	50.0	12.5					
peruanus							1	4	5	7	5		
							4.5	18.2	22.7	31.8	22.7		
gayi								1	9	9	6	3	2
								3.3	30.0	30.0	20.0	10.0	6.7
bilinearis													
Wildwood U. S. Nat. Mus. 118224						2	76	130	57	8	4		
						0.7	27.4	46.9	20.6	2.9	1.4		
All other samples					3	11	80	51	10	1			
					1.9	7.1	51.3	32.7	6.4	.6			

TABLE 3.—*Frequency distribution of the total number of gill rakers on the outer gill arch in American species of* Merluccius

Species and subspecies	Distribution																
	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25
albidus	4	24	10														
	10.5	63.2	26.3														
magnoculus	1	26	5														
	3.1	81.3	15.6														
polylepis					1	5	2										
					12.5	62.5	25.0										
hubbsi					6	10	21	5									
					14.3	23.8	50.0	11.9									
bilinearis							4	16	131	128	97	45	9	3			
							0.9	3.7	30.3	29.6	22.4	10.4	2.1	0.7			
productus									1	2	3	4	5	8			
									4.4	8.7	13.0	17.4	21.7	34.8			
angustimanus								8	7	1							
								50.0	43.7	6.3							
peruanus									1	2	4	6	5	3	1		
									4.5	9.1	18.2	27.3	22.7	13.6	4.5		
gayi										1	4	9	6	4	3	2	1
										3.3	13.3	30.0	20.0	13.3	10.0	6.7	3.3
bilinearis																	
Wildwood U. S. Nat. Mus. 118224								6	63	86	73	38	8	3			
								2.2	22.7	31.0	26.4	13.7	2.9	1.1			
All other samples							4	10	68	42	24	7	1				
							2.6	6.4	43.6	26.9	15.4	4.5	0.6				

TABLE 4.—*Frequency distribution of the number of rays in the first dorsal in American species of* Merluccius

Species and subspecies	Distribution				
	10	11	12	13	14
albidus		21	16	1	
		55.3	42.1	2.6	
magnoculus		1	28	3	
		3.1	87.5	9.4	
polylepis		2	2		
		50.0	50.0		
hubbsi		4	10	2	1
		23.5	58.8	11.8	5.9
bilinearis		4	23	14	3
		9.1	52.3	31.8	6.8
productus	2	6	4		
	16.7	50.0	33.3		
angustimanus		2	6		
		25.0	75.0		
peruanus		9	2		
		81.8	18.2		
gayi	2	9	3	1	
	13.3	60.0	20.0	6.7	

TABLE 5.—*Frequency distribution of the number of rays in the second dorsal in American species of* Merluccius

Species and subspecies	Distribution									
	36	37	38	39	40	41	42	43	44	45
albidus		3	14	14	5					
		8.3	38.9	38.9	13.9					
magnoculus	2	6	10	11	2		1			
	6.3	18.8	31.2	34.4	6.3		3.1			
polylepis								2	1	1
								50.0	25.0	25.0
hubbsi		6	8	2	1					
		35.3	47.1	11.8	5.9					
bilinearis		2	3	13	15	9	2			
		4.5	6.8	29.6	34.1	20.5	4.5			
productus				1	4	3	3		1	
				8.3	33.3	25.0	25.0		8.3	
angustimanus	2	3	1	2						
	25.0	37.5	12.5	25.0						
peruanus	2	2	5	1	1					
	18.2	18.2	45.4	9.1	9.1					
gayi		1	2	5	2	3	1			
		7.1	14.3	35.7	14.3	21.4	7.1			

TABLE 6.—*Frequency distribution of the number of anal rays in American species of* Merluccius

Species and subspecies	Distribution									
	36	37	38	39	40	41	42	43	44	45
albidus		5	10	14	5	2				
		13.9	27.8	38.9	13.9	5.6				
magnoculus		1	4	12	11	4				
		3.1	12.5	37.5	34.4	12.5				
polylepis							1	2		1
							25.0	50.0		25.0
hubbsi		3	2	8	4					
		17.6	11.8	47.1	23.5					
bilinearis				5	14	20	5			
				11.4	31.8	45.5	11.4			
productus						5	4	2	1	
						41.7	33.3	16.7	8.3	
angustimanus		2	3	2	1					
		25.0	37.5	25.0	12.5					
peruanus	1	2	4	4						
	9.1	18.2	36.4	36.4						
gayi				6	7	1	1			
				40.0	46.7	6.7	6.7			

TABLE 7.—*Frequency distribution of the number of pectoral rays in American species of* Merluccius

Species and subspecies	Distribution						
	12	13	14	15	16	17	18
albidus		1	7	18	6		
		3.1	21.9	56.2	18.8		
magnoculus	1	19	11	1			
	3.1	59.4	34.4	3.1			
polylepis		1	2	1			
		25.0	50.0	25.0			
hubbsi			7	9	1		
			41.2	52.9	5.9		
bilinearis		4	16	20	3	1	
		9.1	36.4	45.5	6.8	2.3	
productus			1	3	8		
			8.3	25.0	66.7		
angustimanus				1	3	4	
				12.5	37.5	50.0	
peruanus				1	4	5	1
				9.1	36.4	45.4	9.1
gayi				4	5	6	
				26.7	33.3	40.0	

TABLE 8.—*Head length (measurement to distal margin of soft border) in American species of* Merluccius *in thousandths of the standard length, segregated in size groups*

Species and subspecies	Standard length in mm.	Distribution																	
		250	255	260	265	270	275	280	285	290	295	300	305	310	315	320	325	330	335
albidus	75–91											1	1						
hubbsi	62–87							1	1			2	1						
bilinearis	66–93					2	1	1		1									
albidus	114–138							1				1		2	1				
hubbsi	108–160							2	1	1	3	2							
bilinearis	122–158					4				2									
productus	113–134						2												
angustimanus	145–161															1	1	1	1
peruanus	138–148																2	3	4
albidus	173–293						1	2		2	4	2							
magnoculus	189–290										1	3	6	8	2				
polylepis	281–283							1				1							
hubbsi	177–209								1	1									
bilinearis	181–294		3	2	4	8	5	4											
productus	225–272				1		1		1										
angustimanus	235–289													2			1	1	
peruanus	240												1						
albidus	323–376							3	3										
magnoculus	306–378											5	4	2					
polylepis	323–325						1			1									
bilinearis	319–367			1	1	2	1												
productus	318								1										
peruanus	370														1				
gayi	308–389								2			1							
albidus	405–463						2			2									
magnoculus	451													1					
hubbsi	412						1												
bilinearis	413–442				2														
productus	409–459		1			2	2												
gayi	402–478							1	2	3	2	3							
albidus	626												1						
gayi	581								1										
albidus	173–463						3	5	3	4	4	2							
magnoculus	189–451										1	8	10	11	2				

TABLE 9.—*Pelvic fin length in American species of* Merluccius, *in thousandths of the standard length, segregated by size groups*

Species and subspecies	Standard length in mm.	Distribution																		
		110	115	120	125	130	135	140	145	150	155	160	165	170	175	180	185	190	195	200	205
albidus	75–91															1	1				
hubbsi	62–87												1		1		2		1		
bilinearis	66–93															1	2		1		1
albidus	114–138																1	2	1		
hubbsi	108–160												2	2	3	1	1				
bilinearis	122–158													1			3	2			
productus	113–134				2																
angustimanus	145–161								3	1											
peruanus	138–148							2	3	2	2										
albidus	173–293										1	3	3		3						
magnoculus	189–290						5	3	3	6	2	1									
polylepis	281–283		1					1													
hubbsi	177–209												1		1						
bilinearis	181–294												1	5	7	4	3	3	3		
productus	225–272			1	1			1													
angustimanus	235–289							2	2												
peruanus	240								1												
albidus	323–376									1	3		1		1						
magnoculus	306–378			2		2	4	3													
polylepis	323–325					1	1														
bilinearis	319–367												1	2	1		1				
productus	318						1														
peruanus	370								1												
gayi	308–389						2		1												
albidus	405–463							1		1	1	1									
magnoculus	451			1																	
hubbsi	412						1														
bilinearis	413–442									1		1									
productus	409–459	1	1	1	1	1															
gayi	402–478					4	4	2	1												
albidus	626						1														
gayi	581					1															
albidus	173–376									1	4	3	4		4						
magnoculus	189–378			2		2	9	6	3	6	2	1									
bilinearis	66–442									1		1	2	8	8	5	9	5	4		1
productus	113–459	1	1	2	4	1	1	1													

TABLE 10.—*Pectoral measurements in American species of* Merluccius, *in thousandths of the standard length, segregated in size groups*

Species and subspecies	Standard length in mm.	Distribution																	
		155	160	165	170	175	180	185	190	195	200	205	210	215	220	225	230	235	240
albidus	75–91							1			1								
hubbsi	85–87			1	1														
bilinearis	66–93							1		1	2			1					
albidus	114–138						1	1				2	1						
hubbsi	125–146								1	1		1							
bilinearis	122–148										2		1	1	1				
productus	134												1						
angustimanus	145–161														2			1	1
peruanus	138–148													1	1	3	2	1	1
albidus	173–293							1		1	5	1	1						
magnoculus	189–290		2		5	7	2	1	1										
polylepis	281–283					1		1											
hubbsi	177–209										2								
bilinearis	181–294									1	1	4	3	4	2	4	1	2	1
productus	225										1								
angustimanus	235–289												1	1		1		1	
peruanus	240																1		
albidus	323–376								2	2	1		1						
magnoculus	306–378	1	5	2			1	1											
polylepis	323–325								2										
bilinearis	329–367												2	1			1		
productus	318															1			
peruanus	370																1		
gayi	308–389										2		1						
albidus	405–463							1		1		1		1					
magnoculus	451		1																
hubbsi	412						1												
bilinearis	413–442								1				1						
productus	409–459									1	1		1	1					
gayi	402–478										1	3	2	4	1				
albidus	626							1											
gayi	581													1					
albidus	75–626						1	5	2	4	7	4	3	1					
magnoculus	189–451	1	8	2	5	7	3	2	1										

TABLE 11.—*Maxillary length in American species of* Merluccius, *in thousandths of the standard length, segregated by size groups*

Species and subspecies	Standard length in mm.	Distribution																	
		124	127	130	133	136	139	142	145	148	151	154	157	160	163	166	169	172	175
albidus	75–91															1			1
hubbsi	62–87							1		1	1			1					
bilinearis	66–93					1	1		2	1									
albidus	114–138										1		1	1	1	1			
hubbsi	108–160			1		4	1			1	2								
bilinearis	122–158				1		2	1	1										
productus	113–134			1		1													
angustimanus	145–161									1	1					1			
peruanus	138–148									1	2	3	2		1				
albidus	173–293			1		3	1	1	2	2	1								
magnoculus	189–290								1		5	6	4	2	2				
polylepis	281–283							1			1								
hubbsi	177–209								1	1									
bilinearis	181–294	1		3	5	10	4	1	1	1									
productus	225–272			1	1	1													
angustimanus	235–289								1		1	2							
peruanus	240								1										
albidus	323–376					1	1	3	1										
magnoculus	306–378									2	3	1	3	2					
polylepis	323–325									2									
bilinearis	319–367				1	2	1	1											
productus	318			1															
peruanus	370										1								
gayi	308–389				2	1													
albidus	405–463						1	1	1		1								
magnoculus	451													1					
hubbsi	412					1													
bilinearis	413–442					2													
productus	409–459		1	1	2	1													
gayi	402–478		1	1	1	5		1	1	1									
albidus	626														1				
gayi	581				1														
albidus	173–463			1		4	3	5	4	2	2								
magnoculus	189–451								1	2	8	7	7	5	2				

TABLE 12.—*Snout length in American species of* Merluccius, *in thousandths of the standard length, segregated by size groups*

Species and subspecies	Standard length in mm.	Distribution											
		83	86	89	92	95	98	101	104	107	110	113	116
albidus	75–91						2						
hubbsi	62–87			1	1	3							
bilinearis	66–93	1		1	1	1	1						
albidus	114–138						1	1	1	1	1		
hubbsi	108–160				1	2	6						
bilinearis	122–158			1	3		1	1					
productus	113–134				2								
angustimanus	145–161								3	1			
peruanus	138–148						1	2	3	3			
albidus	173–293				2	2	4	2	1				
magnoculus	189–290						2	1	7	2	4	2	2
polylepis	281–283					1				1			
hubbsi	177–209					1	1						
bilinearis	181–294		2	9	9	4		1	1				
productus	225–272			1	1	1							
angustimanus	235–289								1	1	2		
peruanus	240							1					
albidus	323–376				3		2	1					
magnoculus	306–378					1		2		1	4	2	1
polylepis	323–325								1	1			
bilinearis	319–367			1	1	2		1					
productus	318						1						
peruanus	370								1				
gayi	308–389			1		1		1					
albidus	405–463					1	2	1					
magnoculus	451									1			
hubbsi	412			1									
bilinearis	413–442			1	1								
productus	409–459	1			2		1	1					
gayi	402–478				1	2	4	1	2	1			
albidus	626								1				
gayi	581						1						

TABLE 13.—*Eye measurements in American species of* Merluccius, *in thousandths of the standard length, segregated by size groups*

Species and subspecies	Standard length in mm.	Distribution													
		45	48	51	54	57	60	63	66	69	72	75	78	81	84	87
albidus	75–91												1		1	
hubbsi	62–87												1	3		1
bilinearis	66–93								1		1	1		1	1	
albidus	114–138					1			1	1	1	1				
hubbsi	108–160								2	5	2					
bilinearis	122–158							1	3	1	1					
productus	113–134									1	1					
angustimanus	145–161							1		1	1	1				
peruanus	138–148							2	2	3	2					
albidus	173–293				2	3	1	3	2							
magnoculus	189–290						1	3	4	8	2		1	1		
polylepis	281–283		1	1												
hubbsi	177–209							1		1						
bilinearis	181–294		1	1	5	9	3	5	1	1						
productus	225–272				1	1			1							
angustimanus	235–289						2	2								
peruanus	240							1								
albidus	323–376			2	2	1	1									
magnoculus	306–378				3	3		3		1		1				
polylepis	323–325		1		1											
bilinearis	319–367	1	1		1	2										
productus	318						1									
peruanus	370						1									
gayi	308–389				1				1	1						
albidus	405–463		1			3										
magnoculus	451						1									
hubbsi	412					1										
bilinearis	413–442		1		1											
productus	409–459		1	2	2											
gayi	402–478			3	4	3	1									
albidus	626		1													
gayi	581		1													

TABLE 14.—*Depth of body, measured at origin of first dorsal, in American species of* Merluccius, *in thousandths of the standard length, segregated by size groups*

Species and subspecies	Standard length in mm.	Distribution													
		135	140	145	150	155	160	165	170	175	180	185	190	195	200
albidus	75–91									1	1				
hubbsi	62–87				3	1		1							
bilinearis	66–93								1		3	1			
albidus	114–138						2			1	1				
hubbsi	108–160							4	3	2					
bilinearis	122–158					1				2		3			
productus	113–134					2									
angustimanus	145–161					1	1	2							
peruanus	138–148							2	3		1	1	1	1	
albidus	173–293		1	1		1	2		2		2	2			
magnoculus	189–290				2		3	1	3	3	2		2	1	3
polylepis	281–283		1		1										
hubbsi	177–209				1						1				
bilinearis	181–294		1	2	1	6	6	3	2	4	1				
productus	225–272					1	1	1							
angustimanus	235–289							1			2		1		
peruanus	240						1								
albidus	323–376							1			4				
magnoculus	306–378							3	1		1	2	2	1	1
bilinearis	319–367	1			1	1		1	1						
productus	318				1										
peruanus	370					1									
gayi	308–389									1					
albidus	405–463														
magnoculus	451														
hubbsi	412														
bilinearis	413–442														
productus	409–459														
gayi	402–478														
albidus	626								1						
gayi	581								1						

TABLE 15.—*Caudal length in American species of* Merluccius, *in thousandths of the standard length, segregated by size groups*

Species and subspecies	Standard length in mm.	Distribution															
		102	105	108	111	114	117	120	123	126	129	132	135	138	141	144	147
albidus	75–91					1			1								
hubbsi	85–87											2					
bilinearis	66–93										1	2		1	1		
albidus	124–137							1		1							
hubbsi	108–160							1		2			1	2	2	1	
bilinearis	122–135							1				1	1				
angustimanus	159–161				1		1										
peruanus	138–148								1	3	1	3	1				
albidus	173–293			1	1		2	1	1								
magnoculus	189–290			1	1	1	3	2	3	3	2	1			1		
polylepis	281–283	1			1												
hubbsi	177–209									1					1		
bilinearis	181–294						2	2	1	4	1	3	1		2		1
angustimanus	257–289						1		1		1						
peruanus	240										1						
albidus	323–371				1		2		2								
magnoculus	306–378			1	1	1	2	1	1	2							
polylepis	323–325						1		1								
bilinearis	329–367								1		1						
productus	318						1										
peruanus	370															1	
gayi	308–389				1			2									
albidus	405–463				1		1		1		1						
magnoculus	451						1										
hubbsi	412				1												
bilinearis	413						1										
productus	446													1			
gayi	402–478				1	1		3		2	2	2					
albidus	626				1												
gayi	581			1													